The Children of the Reformation: Childhood Palaeoepidemiology in Britain, AD 1000–1700

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CHILDHOOD IS A TIME of rapid biological growth and development and a stage of the life course during which bodies are particularly sensitive to social and environmental stressors. As a consequence, events which may impact upon a child's care and treatment can become physically embodied within their bones and teeth. The skeletal remains of children have been neglected within archaeological discourse until recently, but they are, in fact, a particularly important demographic for understanding the impact of social processes on past population health. This research examines the prevalence of skeletal disease in children (≤16 years) in Britain (England, Wales and Scotland) between AD 1000–1700. Data for a total of 4626 children from 95 sites were collated from published and unpublished skeletal reports and analysed for evidence of skeletal changes reflecting disease. A biocultural approach was adopted in which the evidence was interpreted in relation to ecological, social, economic and environmental conditions. It was observed that childhood levels of skeletal stress did increase significantly after AD 1540. It was noted that during the Reformation sociocultural and economic factors added to stressors in the ecology of the medieval child. The effects of the Reformation were found to be the greatest aggravator in the rise of morbidity prevalence over seven centuries. Differences in morbidity patterns between non-adult age categories indicated that a state of 'childhood' existed until at least eleven years of age, after which there appears to have been a gradual transition into adolescence and adulthood.

After the end of the Wars of the Roses in AD 1485, Henry VII's focus on fiscal management of the country provided an economic stability that England had not experienced in over a century.[3] The *Valor Ecclesiasticus* is evidence of how pre-Reformation hospitals were providing genuinely beneficial relief to the poor and sick.[4] Children, particularly those in poverty or experiencing poor health, were often aided by monastic institutions; through alms, education and sanctuary.[5] The religious reforms of AD 1535–50 saw the dissolution of not only the majority of religious houses in England, but also of the hospitals, alms houses and fraternities which they ran.[6] The Reformation was not merely a religious phenomenon; it affected all aspects of life and had long-lasting sociocultural ramifications. The reforms had dramatic and rapid repercussions in relation to charitable care: alms giving and the majority of treatment of the sick disappeared in less than a decade, with nothing to substitute for this loss.[7] Compounding this shift further, the post-Reformation economy became increasingly unstable and in conjunction with escalating population pressures caused widespread social stress and urban poverty.[8] This study aims to examine the impact of this upheaval on the health of the population as evidenced through the analysis of the skeletal remains of children dating to both the pre- and post-Reformation periods. We hypothesize that skeletal indicators of poor health amongst children will be greater from those sites dating to the post-Reformation period.

Children would have accounted for 40–65% of most ancient populations, yet non-adult (≤17 years old) palaeopathology remains a largely understudied topic in archaeology. The plasticity of the human body during the early years of development renders it far more likely to be shaped by its surrounding environment than in later life.[9] Skeletal markers of non-adult stress can therefore be used as an indicator of a past population's overall health, by measuring the wellbeing of its most fragile and sensitive members.[10] Skeletal evidence provides the most direct evidence of the health status and disease burden of past populations, with skeletal material acting as a *'site of articulation between biology and culture'*.[11] However, osteological material is only of value when it is placed within the correct cultural and environmental contexts, retrieved from historical and archaeological

perspectives. *'It cannot be too strongly emphasized that the pathology of a group is never randomly produced. It is invariably an expression of the stresses and strains to which the people were subjected, a response to their total environment both external and internal. It reflects the climatic conditions under which they lived, their habits of diet, their daily occupations, their choice of clothing or weapons, their social customs and their genetic inheritance'*.[12] This analysis can therefore be used to measure the extent to which health was affected by *'one of the most striking and important changes which occurred within English society and English economy'*.[13]

THE MEDIEVAL CHILD

Both historically and archaeologically 'children' are rarely considered as independent agents — neither socially active nor economically important.[14] Traditionally they have been conceptualised as socially inconsequential, without their own material culture, social networks or social spaces.[15] The first investigations into the medieval child left a legacy that children were unimportant and often neglected members of society, regarded with ambivalence by emotionally detached parents (Fig 1).[16] However, more recent investigations have demonstrated that 'childhood' was considered to be a clearly definable, separate and special stage of medieval life.[17]

Appreciating that 'age' is a multidimensional construct is vital in understanding growth-related studies (Fig 2). Age categories can be divided into three types: biological age (physical growth); social age (culturally constructed); and chronological age (time elapsed since birth).[18] When defining age categories, most archaeologists use these differing definitions interchangeably. The modern Western perception of 'childhood' is based on a chronological measurement which is both socially and lawfully measured, explicitly pertaining to our own culture and in stark contrast to medieval ideals. Osteologically, biological age is measured in order to gain a chronological age from skeletal remains, despite the fact that this may be inaccurate due to cultural and environmental factors. Chronological age is then often used to determine events within a social age group, despite the fact that the social age may have little bearing on the biological age. The lack of synchronicity between these categories means their definitions should not be assumed. Medieval terminology for describing social ageing was both incredibly specific and entirely flexible. Overlapping age categories and transient definitions make it hard to mark exact stages of maturation, but cultural 'rites of passage' can be used to estimate social growth. Technical terminology used to study non-adults is also conflicting and can lead to misunderstandings of what exactly biologically determine a 'child' and stages of 'childhood'.

Weaning, schooling, confirmation and apprenticeship all marked major transitions in a child's life.[19] Biological puberty was medievally understood, as well as being a socially important threshold. Around the time of puberty the Church and State began recognizing the maturation of the 'child' to adolescence with the introduction of work-related laws, taxation and religious confirmation.[20] Medieval art and literature clearly depict several stages of childhood within the ages of life (Fig 3).[21]

Evidence for medieval maturation and periods of risk are plentiful from birth to adolescence. Child rearing and birth were incredibly hazardous throughout the medieval period.[22] With limited medical understanding and intervention available, women were forced to be self-reliant.[23] Exact proportions of birthing mortalities are difficult to access, but it is widely accepted that death was not a rare occurrence for the mother or the infant.[24]

Infant care practices such as swaddling are also likely to have been hazardous and counter-productive to the growth of straight limbs because this inhibits the skin being exposed to sunlight, the principal source of vitamin D absorption, and hence could have increased the potential for the child to develop rickets.[25] Play became important in the development of a child and was encouraged by adults.[26] We may have sentimental notions of childhood play and tend to romanticize this stage of life, but there is a great deal of evidence to suggest that it was particularly important in the medieval period too.[27] Specific material culture for children's play does exist and often reflects children imitating elements of adult life (Fig 4).[28]

During the early years of childhood, most children would have been closely attached to their house — often an environment of high risk to health.[29] Investigation into the 'average' peasant house has refuted assumptions of rough, temporary and inadequate constructions.[30] Many had three or more bays (rooms), a central hearth, thatched roofs and separate space for animals.[31] As children began to move around this space more independently, they opened themselves up to greater risk of injury.[32] Coroners' rolls reveal how younger children sustained trauma within the house and hagiographic accounts indicate that choking, scalding, falling and drowning were particularly common accidents and causes of death at this age.[33] Animals were present in most households and they are believed to have been a frequent source of childhood trauma.[34] With increasing age comes increasing freedom and most children were given latitude to explore their local environment, which could end in further misadventure and trauma (Fig 5).[35]

As children grew and developed they were likely to have been given basic tasks and slowly become productive agents within the household, to counteract their previous negative impact upon the family economy.[36] Greater responsibility and further domestic tasks were likely to be undertaken by relatively young children as soon as they could be productive and helpful.[37] The education of children under the age of five years was entirely informal and solely the prerogative of the parents. Parents did have a perception of the 'mouldable' nature of the young and their need to be instructed from an early age.[38] Education was largely based on learning Christian principles, mixed with customs and etiquette of medieval society and a general transmission of culture to the younger generation.[39] A child's obedience to its parents was a by-product of the Commandments and an important form of social obedience.[40]

From around six years old the medieval child began entering and interacting with the adult world.[41] This was reflected in increasing responsibility in household duties, the beginning of gender divisions between boys and girls, and a higher level of independence.[42] However 'play' continued to be a big part of children's lives, but developed into more structured social group sports such as wrestling and mock fighting, as well as more adult pursuits such as dice and chess.[43] For boys, joining the hunt was a particularly important stage in maturation.[44] 'Playing at war' was also encouraged and boys as young as seven were being taught how to shoot a bow and arrow.[45] Only a small fraction of children received a formal education during the later medieval period, those in more urban areas having a better chance of schooling.[46] The majority of schooling was limited to boys, so further education for girls in skills such as basic literacy was left to the prerogative of parents to informally instruct their children.[47] With most peasant children not receiving a formal education, they would instead learn occupational and domestic skills through the observation and shadowing of their parents.[48] By the age of seven certainly boys, and occasionally girls, could have started apprenticeships — a clear break with the stage of 'childhood'.[49] Boys who were also destined to enter monasteries could start their formal

education at an early age, although some monastic orders restricted formal induction to those over 18 years old.[50]

From approximately 12 years old puberty began, which is believed to have been perceived as a new stage of life in Medieval Britain.[51] From this age the majority of children would officially undertake occupational roles, with boys mostly taking to the fields and girls tending to the household. With this induction into work, higher trauma rates have been reflected in medieval osteological assemblages.[52] Between the 14th and 16th centuries adolescents formed one third of the work force — a substantial sector of the economy.[53] By the age of 14 years children were susceptible to the poll taxation, indicating their matured status in society.[54] Marriage, in theory, could happen at any point after baptism.[55] Whilst there is evidence that young betrothals and marriages did occur, it was certainly not widespread, nor encouraged by the Church.[56] Marriage between the ages of 12 and 16 years did occur, but were certainly not the norm, with marriage being very much a part of adult behaviour.[57]

It should be acknowledged that historically boys are far more visible than girls.[58] A key limitation of bioarchaeological studies of childhood is the inability to reliably estimate sex from non-adult remains; therefore osteological material cannot add new knowledge here.

Overall, despite a general paucity of evidence regarding the medieval child, it is clear that a state of 'childhood' clearly existed and was acknowledged in medieval Britain. It is also clear that a child aged socially through a series of rites of passage, each of which posed specific health risks.

REFORMING BRITAIN

If it is to be hypothesized that the Reformation impacted negatively on the health of children, we need to understand what provisions were available prior to the dissolution of the religious houses, and determine how beneficial they were. The Catholic Church in medieval England permeated society at every level.[59] Children were not exempt from this and were inducted into the Church as lifelong members from baptism.[60] By the 11th century the concern that children embodied the original sin meant that baptism needed to be undertaken as soon as possible, to avoid the risk of purgatory and hell if sudden death occurred.[61] A child's relationship with the Church fundamentally affected how they lived and what they thought; the word of God dictated their morality, their understanding of chastity, justice and charity, even extending to their diet and daily conduct.[62] Some churches and monasteries even provided education for the younger children of the local parish.[63] From 12 years old, confirmation marked the child's ascent into adulthood, entering the Church as a full member, able to receive the Eucharist and incur Church taxation.[64] From this point, boys could choose to enter a monastery and receive a formal education.[65]

With the belief in purgatory and the prospect of a long and painful suffering for one's sins during life, charitable donation to religious houses was a fundamental principle of the medieval Church.[66] The Church promoted a benevolent attitude towards the poor as part of a Christian person's moral obligations.[67] In turn for charitable deeds, salvation became more easily attainable and purgatory shorter.[68] Looking after the poor was essentially seen as a community enterprise, presided over by the Church.[69] Before the introduction of Poor Laws during the 16th century, there was no intervention from the Crown or government to deal with the homeless, poverty stricken and sick.[70] In AD 1536 the

first legislative act for dealing with rising poverty levels made it the responsibility of town authorities to manage the local poor, but it was largely ignored until further laws were passed in AD 1563. These too proved largely ineffective until the introduction of the Poor Laws in AD 1598.[71] This left a 60 year period between the Reformation and the latter Poor Laws, in which there was no charitable infrastructure in place to assist the poor; moreover, this was a period filled with epidemics, an unravelling, debased economy, widespread social instability and escalating levels of poverty.

Poverty management was the job of the Church, but quantifying how effective Church-led poor relief was is problematic. Alms giving and its effectiveness has long been the focus of investigations which deemed these provisions to have been largely inadequate; but new research indicates that in most areas of the country it was at least sufficient.[72] The provision of alms from monastic houses was the poor's only real source of financial assistance.[73] Homeless children in particular were entirely dependent on charitable donations.[74] By AD 1500 around 120,000 people were living below the poverty line, existing on holdings inadequate to feed their entire family, causing their access to basic foodstuffs to be significantly restricted. This rendered approximately 5% of the total population to be so limited in their resources that they depended on alms.[75] In cases of orphaned children, the monasteries would even go as far as feeding and sheltering them.[76] By the early Tudor Period, alms giving increased and the *Valor Ecclesiasticus* is a good indicator that the pre-Reformation Church was providing sufficient alms and managing to cope with escalating levels of poverty.[77] Post Reformation, alms giving was halted and royal confiscation of Church property abolished any beneficial care being provided by the religious houses.[78]

It was not just Britain's charitable infrastructure that was a casualty of the Reformation; the majority of the country's hospitals were connected to the monastic institutions undergoing dissolution. In hospitals spiritual cures included a regime of prayer and confession.[79] With treatment limited, healing was encouraged through the dutiful service of God.[80] However, a lack of direct medieval intervention does not mean that the hospitals were ineffective in promoting healing. The hospitals provided a clean and quiet environment, bed rest, warmth, cleanliness, an adequate diet, exercise, quality nursing and basic treatment which would have been genuinely beneficial therapy for sickness.[81] Hagiographic accounts indicate that most illnesses and accidents would have been curable by basic medical treatment, rest and adequate nutrition.

Medieval economic oscillations affected access to food, wages and rates of employment. Economic unrest should provoke changes in the health of the population, with the relationship between the economy and morbidity patterns being of great importance. It is often disregarded that children were major contributors to the economy; yet children over the age of 12 years represented a substantial portion of the medieval workforce.[82] Post-Conquest evidence is sparse, but suggests that the relative stability of politics, the development of the seigneurial economy and the expansion of agriculture led to a relatively balanced and calm economic climate.[83] This lasted until the rapid population growth experienced at the end of the 12th century that led to overcrowding and food shortages, exacerbated by the outbreak of minor plagues.[84] By the mid-14th century people were experiencing overpopulation, high inflation and harvest failures that frequently left the lower classes of society without basic food and drink on regular occasions.[85] The significant decline in the population as a consequence of the Black Death saw an increase in work, wages and food supply, all of which stimulated economic growth and caused a decrease in poverty levels.[86] However, once the initial economic upheaval ended, most lower classes

found themselves worse off, as lower demand for food soon meant a rise in the cost of manufactured goods which the wage increase did not match.[87] A shift in labour patterns occurred as women filled the economic gap in the labour market created by the Black Death.[88] It can be hypothesized then, that children who spent their time shadowing their mothers and often following them to the workplace are likely to have played a significant role in filling the economic gap as well. By the 15th century epidemics and constant warfare led to economic depression. This stagnation lasted up until the reign of Henry VII, whose focus on securing economic stability at the end of a turbulent period ensured a measure of economic prosperity.[89] In the first quarter of the 16th century high wages, good harvests, easy tenures and low rents made for affluent conditions.[90] By 1530 market growth slowed, likely in response to a succession of poor harvests and outbreaks of plague.[91] These problems were matched by population increase, rising levels of poverty and higher taxation.[92] By 1563 a further series of plagues and poor harvests led many more people to drop below the poverty line, with no provisions for assistance.[93] These overarching economic fluctuations are likely to have impacted on the health and well-being of the medieval child, and should be visible palaeopathologically.

THE STUDY OF NON-ADULT PALAEOPATHOLOGY

Palaeopathology is the study (*logos*) of ancient (*palaeo*) suffering (*pathos*), or the scientific study of tissue abnormalities caused by disease in the archaeological record. The study is chiefly restricted to pathologies which affect the skeleton and therefore only provides a very partial picture of past morbidity. Studies of skeletal indicators of childhood health stress provide a broader picture of overall population health. Children represent a particularly vulnerable segment of any population; they require care to survive and their bodies provide a sensitive measure of intrinsic/extrinsic factors. This makes them important tools for social reconstruction. Age estimation of the skeletal remains of non-adults can be achieved more accurately and reliably than for adult skeletons, thus allowing a more detailed study of the fluctuations of mortality and morbidity data in the past, and greater resolution for the identification of diachronic and synchronic trends. The skeletons of younger children (0–3 years) in particular can be useful for interpreting past health and their remains have been viewed as passive barometers of their environment, constrained as they are by their highly dependent, immature physiology and constant demand for nutrition.[94] Their undeveloped immune systems also make them more likely to contract disease, therefore rendering them especially sensitive to past social and physical environments.[95] Non-adults in the archaeological record reflect 'non-survivors' — those individuals who have been unable to adapt and survive environmental stressors. Studies of these 'non-survivors' have revealed evidence for maternal health, cultural practices, disease prevalence, obstetric practices, infant feeding and attitudes towards 'childhood'.

In order to explore non-adult health it is first important to define what constitutes 'health' and where the point of negative 'health' occurs. From the old English 'hale' ('wholeness', 'wellness'), health is not just the absence of disease, nor is it a universally perceived ideal. The perception of 'health' is considerably different depending on factors such as geography, culture and individuality.[96] Although only very few pathologies cause skeletal changes, when they do occur it is a clear sign of imbalance (stress) of an individual's equilibrium (health). Health or disease is the expression of the success or failure of an

organism in its efforts to respond adaptively to environmental and sociocultural challenges (Fig 6).[97]

When studying non-adult skeletons, one must be aware of the limitations which compromise their evidential value in the reconstruction of past populations. Pathologies that affect the skeletal system cause limited bony reactions; therefore diagnosing specific diseases can be problematic, particularly when remains are fragmentary and incomplete.[98] Skeletal changes may also have multiple causes and this further complicates interpretation. For example, vitamin D deficiency causes a condition known as rickets in the skeleton, which is commonly observed by weakened and porous bone. In terms of interpretation, vitamin D deficiency may have derived from multiple causes, including a lack of sunlight, diet and/or cultural practices, so a specific behaviour is hard to identity. This is further complicated by the fact that other conditions may result in similar skeletal lesions (eg anaemia and vitamin C deficiency). Having a completely preserved skeleton available for analysis will certainly aid diagnosis, but this is often not the case from archaeological contexts. The morphology and rapid remodelling of non-adult bone makes identifying trauma especially problematic and trauma rates are therefore likely to be significantly underrepresented.[99] Evidence of non-adult trauma relating to occupation, interpersonal violence, accidents, treatment and care is not commonly reported in the archaeological record. It is also not possible to distinguish new periosteal bone growth as a sign of normal developmental growth, or a sign of a palaeopathological incident, caused by a incident of trauma or infection[100]. Furthermore, while evidence of disease may be recorded at the time of death, it is often not possible to determine the age at which the disease process commenced or a traumatic episode occurred. Perhaps the single greatest issue facing the study of non-adult palaeopathology is the inability to reliably assign a biological sex to remains.[101] Determining sex in adults is based upon differences in morphological features of the skull, pelvis and long bones between males and females. However these changes do not commence until puberty, making sex determination of a skeleton under the age of 17 generally unreliable.[102]

Non-adult remains are also regarded as less likely to be preserved in the archaeological record. Often accorded different funerary rites and spatially differentiated from adult burials, skeletal evidence for non-adults is often underrepresented.[103] Shallow interments and burial styles could also have caused non-adult burials to be more prone to scavenging and plough disruption.[104] Intrinsic factors of non-adult skeletons render their bones less likely to survive decay processes as their high organic components and correspondingly low mineral content make them more susceptible to decomposition.[105] Bone morphology could also be further weakened by the destruction of bone by pathological processes.[106] Excavator skill is often a key problem; significant care and knowledge are required in order to retrieve the small bones and unfused epiphyses, which may be mistaken for soil inclusions.[107] Considering these issues, it is highly unlikely that any collection is not in some way biased. In the last 10,000 years, an estimated 100 billion people have died, but only an incredibly small fraction have entered and been recovered from the archaeological record.[108] Knowing exactly what subsample of the population a skeletal collection represents needs to be questioned. Our ability to make statements about the past is entirely dependent on the representativeness of archaeological samples, yet no cemetery collection is a single, static sample of the local ancient population, in which all the members are proportionally represented (Fig 7).[109]

Even within an ideal, bias free, skeletal sample there is the issue of whether or not a dead population has any relevance when compared to a past living population.[110] Formation

of mortuary contexts is complex and our current mortuary categorizations and interpretations are often overly simplistic. Instead of representing individuals of poor health, skeletons with pathological lesions could paradoxically reflect individuals compromised enough to contract a disease, but strong enough for it to develop into its chronic stages.[111] Non-adult remains without lesions could therefore reflect individuals of weak health or the victims of a particularly virulent disease. Palaeopathologists must therefore be cautious when interpreting the data derived from skeletal assemblages. Measuring rates of *morbidity* (levels of sickness and disease) is likely to be more accurate and better reflective of a past population's interaction with disease.[112] The focus of palaeopatholological analysis should be altered to a more conjectural palaeoepidemiological study of stress indicators that demonstrate diachronic fluctuations of morbidity rates. The result should be viewed not as a perfect representation of the health status of the living population, but instead as an indication of disease fluctuations and crude patterns of pathological trends. The scientific study of human skeletal material is often problematic, as the material does not lend itself to the precision necessary to produce work directly comparable with clinical epidemiological studies. However, it is still generally considered that rates of morbidity do bear some reflection of the living population,[113] particularly when one adopts a more multidisciplinary, holistic approach by contextualizing the evidence. The issues discussed above are not intended to present a negative picture of the study of non-adult palaeopathology; instead they aim to emphasize particular problems that must be addressed before attempting to assert an interpretation regarding paleoepidemiological research. Non-adult palaeopathology provides an otherwise unattainable source of information about past populations and can illuminate important factors of past societies.

MATERIALS & METHODS

Skeletal data from sites in England, Wales and Scotland were collected from contexts dated to the period of study AD 1000 to AD 1700 from both published and unpublished reports. Data from Scotland was included in the hope that comparisons could be drawn between the different timing in religious and political changes between England and Scotland. The broad time span was adopted in order to observe long-term trends in health patterns, so that the later medieval period could be interpreted within a wider context. No sites within these parameters were excluded from consideration. Data were downloaded from the *Requiem* database and the *Museum of London Centre for Human Bioarchaeology Online Wellcome Osteological Research Database.*[114] Published reports were gathered from the British Library and grey literature was collected from the *Archaeology Data Service* and commercial archaeological units. While primary data analysis is the most desirable method, it is not feasible with such a large sample as presented here. Further, recent efforts in the standardisation of skeletal reports has meant that those dating to within the last two decades are much more detailed and comparable in terms of their presentation of the pathological data than previously. A few older reports were omitted due to their lack of sufficient recording. The quality of grey literature reports is somewhat variable, with older reports likely to be based on outdated standards and inefficient recording schemes, thereby under-representing pathological conditions and making these assemblages appear healthier.

The data were split into three age groups: foetal–5 years, 6–11 years and 12–16 years old. These were chosen to be reflective of medieval perceptions of childhood whilst allowing for the practicalities of data manipulation from mostly grey literature. In instances

where ranges described non-adults as '3–6 years' or '11–13 years' the average age was assumed. With the majority of reports not containing catalogues of data, the figures for disease prevalence were extrapolated from the text, where possible. The few occurrences of cremated material were not included as most site reports failed to undertake substantial enough pathological descriptions. In total, 95 sites and 4,647 skeletons were included in this study (Fig 8).

Many medieval skeletal assemblages are known from across the country; the vast majority are datable due to the events of the Reformation and dissolution of the monasteries. However, datable post-medieval burial grounds, particularly those immediately after the Reformation, are rare.[115] The data are sparse, badly phased and often poorly reported upon, with cemeteries being used for too long a time-span to allow for accurate dating.[116] Due to the nature of commercial archaeology, urban sites are over-represented; only 6% of the medieval population of Britain were living in urban areas by the Reformation.[117] Understanding exactly who the non-adults represent within medieval society is important when trying to avoid including inherent evidential biases. The majority of medieval people would have been buried in parish grounds or cathedral cemeteries, rather than in monastic grounds.[118] From the 12th century onwards, monastic burial became extended to and encouraged for the laity, in return for money, land or possessions.[119] Contrary to some misconceptions, children could be buried in monastic grounds, fee permitting.[120] Non-adult monastic burials likely represent both young boys who were being educated to become members of the clergy and the families of founders, patrons and beneficiaries of the monasteries, solvent enough to afford the burial cost.[121] There is likely an overrepresentation of non-adults from higher levels of society.[122]

This project aimed to assess the pathological conditions in non-adult remains that best reflect living conditions. These include: scurvy, rickets, cribra orbitalia, tuberculosis, syphilis, leprosy, periosteal new bone formation, osteitis, osteomyelitis, poliomyelitis, mastoiditis, fractures, cranial trauma, osteochondritis dessicans, disuse atrophy, caries, calculus, periodontal disease, periapical cavities, endocranial lesions, and ankylosing spondylosis. Pathological conditions that currently have unknown or ambiguous aetiologies, such as musculoskeletal markers or Harris Lines, were not included in this investigation.[123]In order to make all data comparable, crude prevalence rates were extrapolated from each site (crude prevalence = number of individuals affected/number of individuals in the skeletal sample). Crude prevalence provides a percentage of the numbers of individuals affected by particular pathologies, but does not take into account differential preservation between sites. Although some sites had smaller assemblage sizes than others, it was important to give evidence from each site equal weighting, so that each region's health status was represented. This analysis ultimately provides a measure of how many individuals experienced a disruption to the normal state of 'health' as indicated by the presence of skeletal signs of stress, whether that be trauma, infection or disease. Pathology prevalence was then assigned using an average trendline to assess overall fluctuations and patterns.

RESULTS AND DISCUSSION

From the paleoepidemiological data analysed (Fig 9) it is evident that non-adult levels of morbidity experienced similar fluctuations to adults. Contrary to expectations, levels of morbidity are lower amongst the children, and this may indicate that the non-adults were less susceptible than adults to sociocultural and environmental stressors. It

could be that non-adults were buffered or protected from stresses by their care-givers, or that they simply died from acute diseases prior to any skeletal manifestation.[124]

Skeletal stressors increased from the 12th to 14th centuries, with a marked decrease around the time of the Black Death — likely a response to more favourable economic conditions, with the surviving population enjoying a 101% wage increase over two years, expanded employment opportunities and an increased access to food.[125] From AD 1350–1500 there was an extended episode of stability in the skeletal data, despite the political commotion of the Hundred Years' War and Wars of the Roses causing social disruption throughout this period.[126] These results suggest that a consistent economy and climate were more influential than sociocultural strain on non-adult morbidity levels. Non-adult trauma during this period is higher and tracks closer to adult rates, perhaps indicating that during this century of war, children were less closely supervised than previously. The legacy of stability provided by Henry VII is reflected in a non-adult and adult drop in morbidity rates during the late 15th century. Economic prosperity and steady wages were matched by the high levels of alms giving for hospital foundations.[127] The heightened cost of living and fluctuations in wheat prices do detract from the picture of an entirely prosperous period, possibly indicating episodes of poor harvests and some early symptoms of underlying economic instability.

The data reveal a significant peak in non-adult morbidity around AD 1540. The causes of this can be split into two factors: the effects of the Reformation and external factors with no relation to the reforms. The closure of the monastic houses indirectly led to the halving of hospital provision in England. This was accompanied by a complete loss of alms giving, charitable donation, education and poor management overseen by the Church.[128] The mechanism of Catholic 'social welfare' was removed with nothing to replace this essential national societal foundation. At the same time, the economy began to fluctuate; some of this was likely motivated by the social unrest caused by the Reformation, but the majority of the problems likely stem from unrelated factors.[129] The rise in the cost of living coincides with fluctuations in agricultural wages which most of the population would have depended on, exacerbated by higher rates of taxation.[130] Fluctuations in wheat prices and some environmental evidence of climatic instability; the combination of these indicates a period of climatic worsening.[131] This is supported by a countrywide shift in dental disease, which could be indicative of a change in eating habits. The stagnation in market growth, environmental worsening and a succession of poor harvests led to several outbreaks of plague.[132] This economic unrest occurred at the same time as the support system of the Church was lost. Population expansion caused stresses through increasing urbanization, escalating to major population pressures by the end of the 15th century.[133]

Trends in the non-adult morbidity data also support the historical research that there were clear stages to medieval childhood. Individuals of 0–5 years are clearly the most susceptible to changes in their ecology, with their rates of morbidity being the most affected by periods that have been defined as ecologically better or worse (Fig 10). Significant levels of trauma and infection, that are also likely underrepresented, indicate that this was a particularly fragile time in medieval life. A significant increase in rickets post-Reformation was most prevalent in this age group, perhaps indicating a shift in infant care, or perhaps an extended period of swaddling.[134]

The most common evidence of infectious processes was periosteal new bone formation, arguably a reflection of general living conditions and episodes of trauma, but also highly problematic to accurately diagnose (Fig 11).[135] The 0–5 and 6–11 year olds were

found to exhibit similar rates of periosteal new bone growth. This could indicate a similar lifestyle, with a state of childhood extending to at least 11 years of age. Previous studies have indicated that that 6–11 year olds would have been undertaking a substantial amount of adult tasks.[136] The palaeopathological data indicate that a state of 'childhood' was likely retained for longer than previously assumed. However, By 12–16 years old, morbidity levels become more similar to adult levels. Higher levels of trauma could be an indication of more grown-up activities, such as sporting and hunting, but it could also be an indication of the child's transition into the adult world and undertaking of adult activities.[137] This is reflected in the historical sources, which detail their beginning apprenticeships and occupational roles, as well as their confirmation to the Church and their taxability. Trauma in younger children (0–3 years) is more likely to be indicative of abuse or neglect, with the likelihood of accidental injury increasing with age and mobility.[138] During the 11th to 14th centuries and post-Reformation, 12–16 year olds follow similar patterns of trauma to 0–11 year olds.

Overall, rural trauma and non-specific infection rates track similarly together for 0–5 and 6–11 year olds. Rates for 12–16 year olds are three times greater, but as high as as adult levels (Fig 12). Their level of morbidity is likely underestimated, but even allowing for an escalation in their values, this would likely still be lower than adult levels. The dotted line in Figure 11 indicates the healing time of fractures, which increases with age. This increase is matched by an rise in observed pathology and this shows that non-adult levels of trauma are likely closer to adult levels, but their rate of healing masks traumatic episodes visible in adult skeletons. Exact proportions of how far this affects non-adult data are unclear. Although it is likely that non-adult levels of trauma are in fact higher than we can estimate, the significant differences in the data collected in this study suggest it would still be lower than adult levels.

Between 12 and 16 years of age there is a significant change in activities, but this is still not completely congruent with adult levels (Fig 13). One explanation for this could be that childhood during these periods was extended into adolescence, perhaps indicating an entering into adulthood, but not a complete relinquishing of childhood. Despite previous interpretations that suggested the medieval child was thrust mercilessly into the adult world at a young age, these data indicate not only a sustained period of juvenility, but also a period of transition rather than an abrupt move into adulthood. Interestingly, urban areas show a far less staggered rate of trauma and infection, instead indicating that childhood in urban areas was retained for less time and the transition to adulthood both occurred far earlier and was a more gradual process. However, during the 14th to 16th centuries 12–16 year olds exhibit an adult pattern of trauma. This perhaps reflects a shift in the social norms associated with this particular age group's role in response to the shifting sociocultural environment. Post-Reformation patterns of trauma dramatically change, showing a clear split between adult and non-adult activities and may tentatively been seen to indicate a more prolonged 'childhood'.

With 90% of Vitamin D synthesis depending on at least 20 minutes of sun exposure a day, pathologies caused by the lack of it provide us with a clear example of past lifestyle.[139] Levels of rickets represented in the data steadily increase from the 10th century through to the 15th, when post-Reformation rates treble.

Little work has been undertaken regarding non-adult dental disease.[140] An overall shift in eating habits or dental hygiene can perhaps be inferred from the post-Reformation decrease in dental disease. Caries rates follow surprisingly similar patterns, suggesting little difference in dietary habits between age groups. Post Reformation this pattern changes, and

clear differences emerge. The overall lower rates in 0–5 year olds and 12–16 year olds are likely due to the shorter period of time that their deciduous and permanent teeth have had to develop carious lesions. Calculus levels show a clear distinction between the age groups. A post-Reformation drop in calculus rates suggests a shift in dental hygiene or a change in diet, specifically an increase in carbohydrate consumption.[141]

Paradoxically, the rise in non-adult morbidity post-Reformation could indicate that children, particularly younger non-adults, were being cared for in adverse conditions.[142] Most individuals from the medieval period would have been buried in parish or cathedral cemeteries, with those in monastic grounds likely to be of higher social status.[143] Interestingly, non-adults from monastic cemeteries show significantly higher signs of stress than the 'general public'. Hospital cemeteries contained significantly higher proportions of pathological conditions, which is evidence of their actual treatment of individuals with life impacting conditions. The higher levels of morbidity in hospital cemeteries could also be viewed as evidence of non-adults receiving treatment that made it possible for them to survive a period of health stress or particular disease into its chronic stages. The hospital assemblage also indicates that the dead population are indeed more likely to have skeletal indicators of ill health, making them appear sicker than the surviving population.[144] Whilst it is important to note the potentially paradoxical nature of osteological evidence, considering the quantity of data analyzed here, it is still more likely that the rise in morbidity is reflective of overall trends and fluctuations in the health of the living.[145] It could also be hypothesized that the underrepresentation of morbidity in younger non-adults could actually mean that there is very little difference in true prevalence rates. However the significance difference in the data between age categories still indicates that there were marked difference in risk and morbidity patterns during maturation.

CONCLUSION

The evidence presented above suggests that the child in reforming Britain experienced changes directly related to the dissolution of the monastic houses. The significant peak in non-adult morbidity at the Reformation is a clear indication of heightened stressors in the sociocultural fabric of Britain. These changes caused more significant fluctuations in palaeopathological data than any prior climatic worsening or economic turmoil.[146] The environment of the medieval child was composed and constructed by the Christian Church through the word of God.[147] Royal usurpation of this role saw the disbanding not only of the physical reality of the Church's infrastructure, but the sociocultural foundations of medieval society.[148] These changes to the fundamental environment of a child were rapid and led to the abrupt cessation of 'Catholic social welfare', supplementary support and relief provision.[149] The children of the Reformation who found themselves in need of alms, education, shelter or medical care would have received no formal support, in a country where famine, harvest failures and a heightened cost of living was producing widespread social disorder.[150] These sources of cultural unrest were slowly attended to, but political changes implemented to combat these shortcomings took more than a decade to fully develop, and even then they remained largely ineffective.[151] This is reflected in the sharp increase in non-adult morbidity, followed by a gradual recovery. Although there are difficulties posed by interpreting palaeoepidemiological data, when the limitations are clearly defined, these can still be an ambient signal of past health patterns. Clearly a state of 'childhood' was perceived by

medieval society, punctuated by specific stages of maturation. These stages are mirrored in the palaeopathological and historical evidence. Despite some unavoidable generalisations about medieval Britain, the vast amount of data analyzed here produce a convincing osteological profile of childhood in medieval Britain. The Reformation caused the most significant change in non-adult morbidity trends in the entire medieval period.

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